



# **INVESTIGATION METHODS TO DISTINGUISH BETWEEN VAPOR INTRUSION AND INDOOR SOURCES OF VOCS**

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14. ABSTRACT <b>Indoor sources of volatile organic chemicals (VOCs) are ubiquitous, resulting in detectable concentrations in indoor air, often at concentrations above regulatory screening levels. At VOC contaminated sites with potential vapor intrusion concerns, the presence of indoor VOC sources significantly complicates the exposure pathway investigation. Because of these indoor sources, the detection of a site-related VOC in a potentially affected building at a concentration above the regulatory screening level does not necessarily indicate a vapor intrusion impact. Instead, additional analysis is required to determine the sources of the detected VOCs. We have developed several approaches to distinguish between vapor intrusion and indoor sources of VOCs including: (i) use of a field-portable gas chromatograph/mass spectrometer (GS/MS) to evaluate the distribution of VOCs within a building and to identify specific indoor sources of VOCs, (ii) collection of indoor air and sub-slab soil gas samples under controlled negative building pressure conditions designed to maximize vapor intrusion and controlled positive building pressure conditions designed to inhibit vapor intrusion, and (iii) use of compoundspecific stable isotope analysis to determine the original source of VOCs detected in indoor air samples. Each of these methods has been applied to one or more buildings potentially impacted by vapor intrusion and has proved useful to distinguish between vapor intrusion and indoor sources of VOCs.</b>					
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## INVESTIGATION METHODS TO DISTINGUISH BETWEEN VAPOR INTRUSION AND INDOOR SOURCES OF VOCs

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## VAPOR INTRUSION VS. INDOOR SOURCES

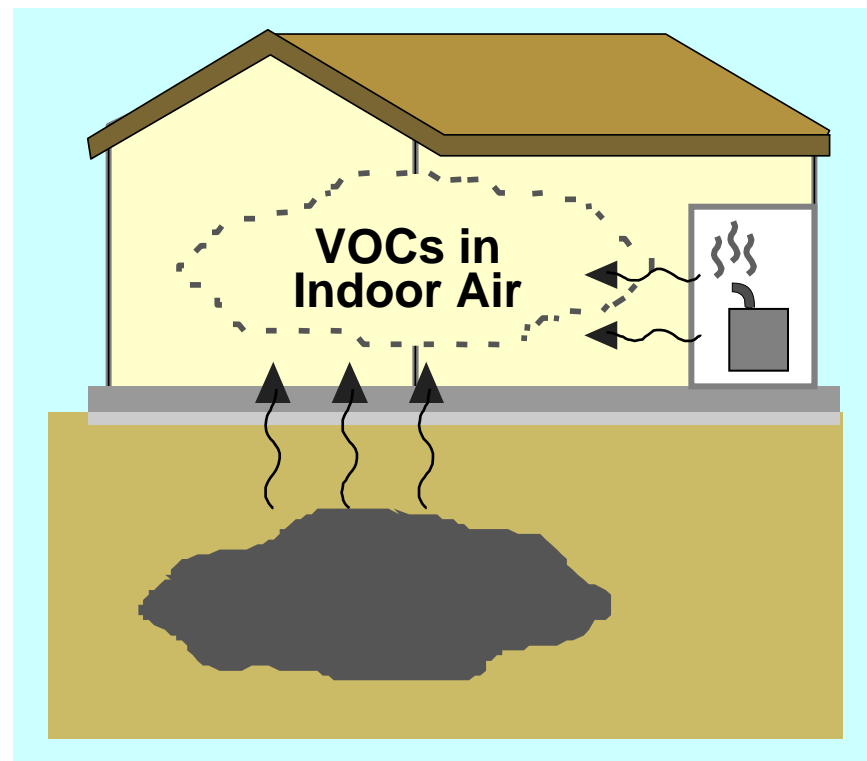
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- **Background: Indoor Sources**
- **On-Site GC/MS**
- **Building Pressure Control**
- **Compound-Specific Stable Isotope Analysis**



# PROBLEM: INDOOR SOURCES

- At a vapor intrusion site, testing of indoor air is the most direct way to identify VI impacts.
- Indoor sources of VOCs are ubiquitous: cleaners, glues, plastic, etc.
- Detection of VOCs in indoor air does not necessarily indicate vapor intrusion.



## **Key Point:**

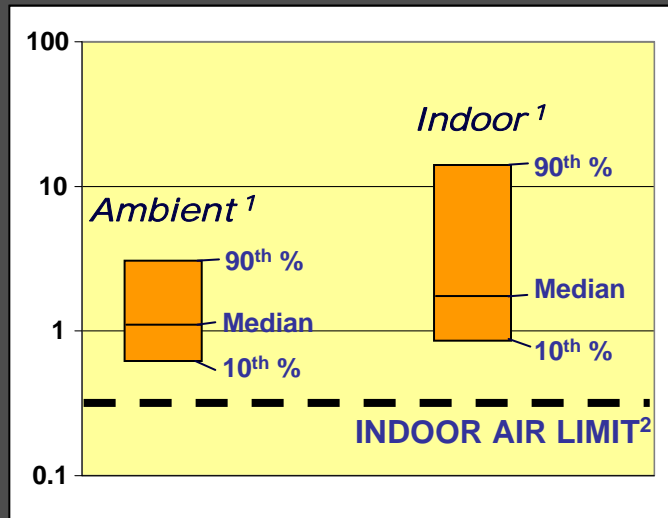
***Critical need for reliable methods to distinguish between vapor intrusion and indoor sources of VOCs.***

# 2004 Background vs. USEPA Risk-Based Limits

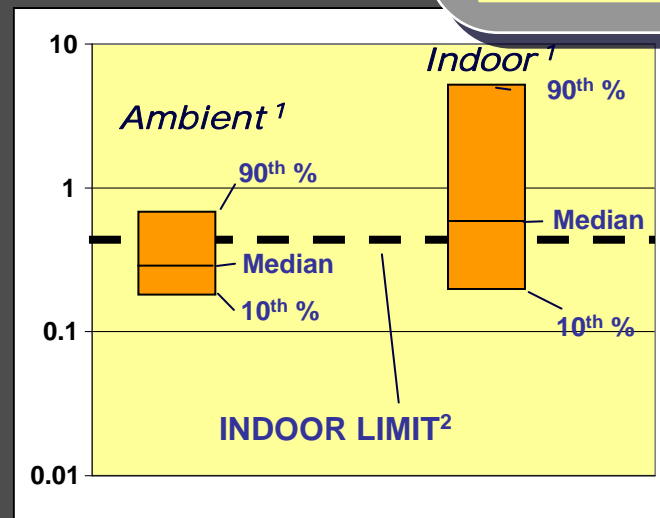


## BENZENE

Range of Reported Background Concentration ( $\mu\text{g}/\text{m}^3$ )



## PCE



### KEY POINT:

Background indoor and outdoor air concentrations commonly exceed risk-based limits for indoor air.

1) Background concentrations from Sexton et al. 2004 ES&T 38(2); 423-430.

2) USEPA Master Screening Values Table, September 2008

# But We Don't Use "TOXIC" Chemicals Anymore



Email bulletin from vendor, October 2010:

## Technical Update

Topics, trends, and news in the environmental industry...

## TCE Contamination Affects Community's Water Wells

"The TCE, which was banned from public use in the 1970s, was detected at levels greater than the U.S. EPA's maximum contaminant level for public drinking water."

### **KEY POINT:**

Many people believe that TCE and other chlorinated solvents are no longer used in industrial operations or consumer products.



# But We Don't Use "TOXIC" Chemicals Anymore.....



**Gun Cleaner:  
\$19.95**

**>90% TCE**



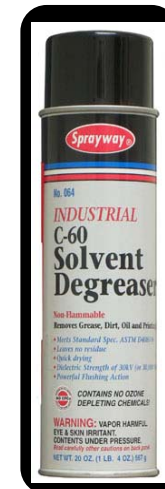
**Pepper Spray:  
\$3.99**

**>90% TCE**



**Brake Cleaner:  
\$12.95**

**50/50 TCE/PCE**



**Solvent Degreaser:  
\$15.95**

**>90% TCE**

## **KEY POINT:**

TCE, PCE, etc., are legal and are still used in a wide range of consumer products currently available for purchase.

# INDOOR SOURCES: Remove before sampling



# INDOOR SOURCES: Find'em if you can



**Key  
Point:**

***Source removal often not practical or effective.  
Need investigation program that deals with  
indoor sources.***



# SOLUTION: TEST METHODS

## POTENTIAL METHODS TO DISTINGUISH BETWEEN VAPOR INTRUSION AND INDOOR SOURCES OF VOCs

### Real-time On-site Analysis

- Used successfully by USEPA and Hill AFB
- Requires expensive equipment: Hapsite GC/MS or USEPA TAGA unit.

### Building Pressure Control

- Current ESTCP Project ER-0707
- May not be suitable in very large or very leaky buildings.

### CSIA / Fingerprinting

- Completed “Proof of Concept” study
- Potentially simplest method to apply on routine basis.

**KEY POINT:** *Indoor “fear factor” will disappear when we can accurately identify the source of the VOCs.*



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Covered by  
Kyle in  
previous talk





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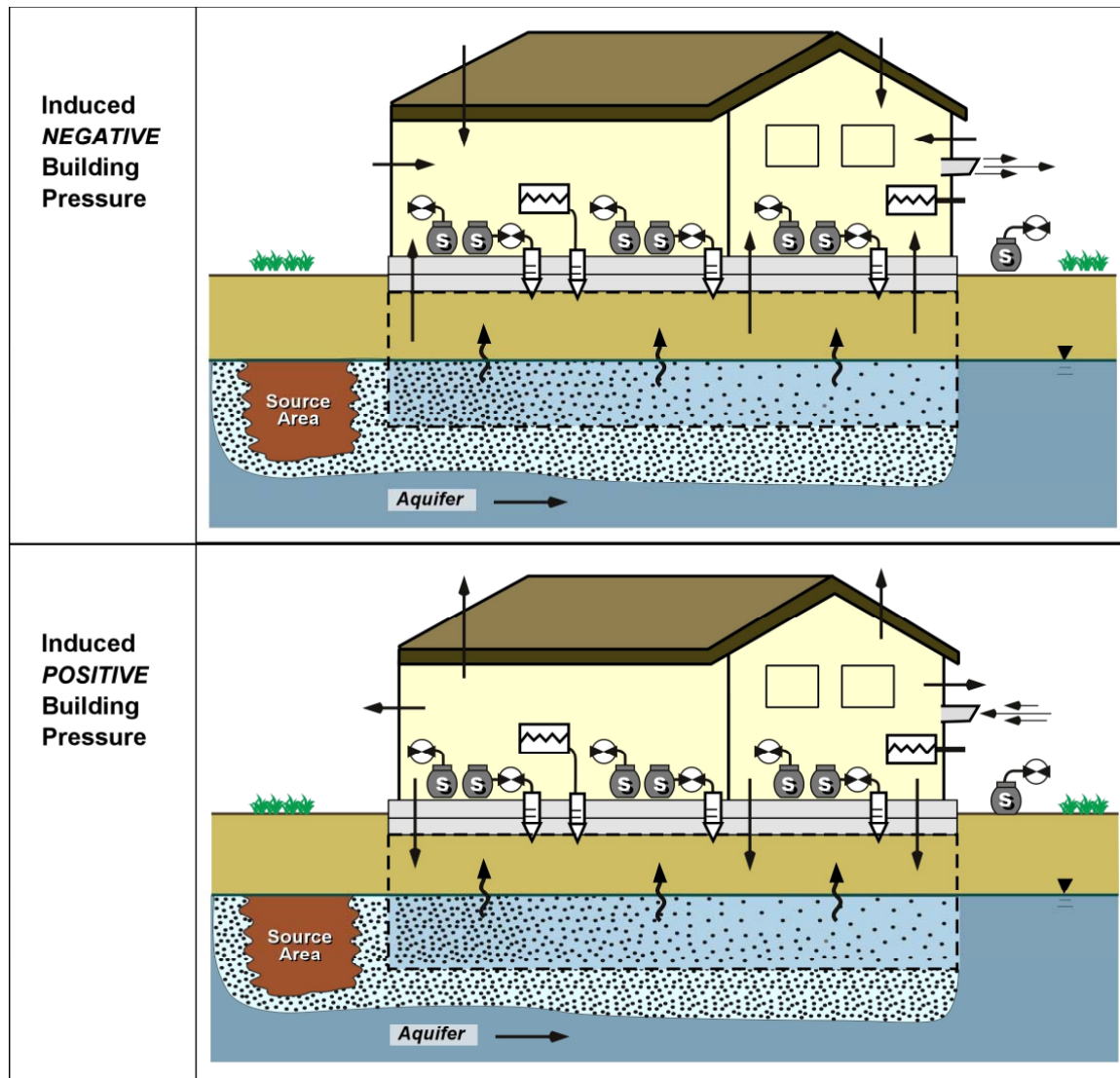
# PRESSURE CONTROL: OVERVIEW



## Concept:

1) Use controlled **NEGATIVE** building pressure to **MAXIMIZE** vapor intrusion.

2) Use controlled **POSITIVE** building pressure to **TURN OFF** vapor intrusion.



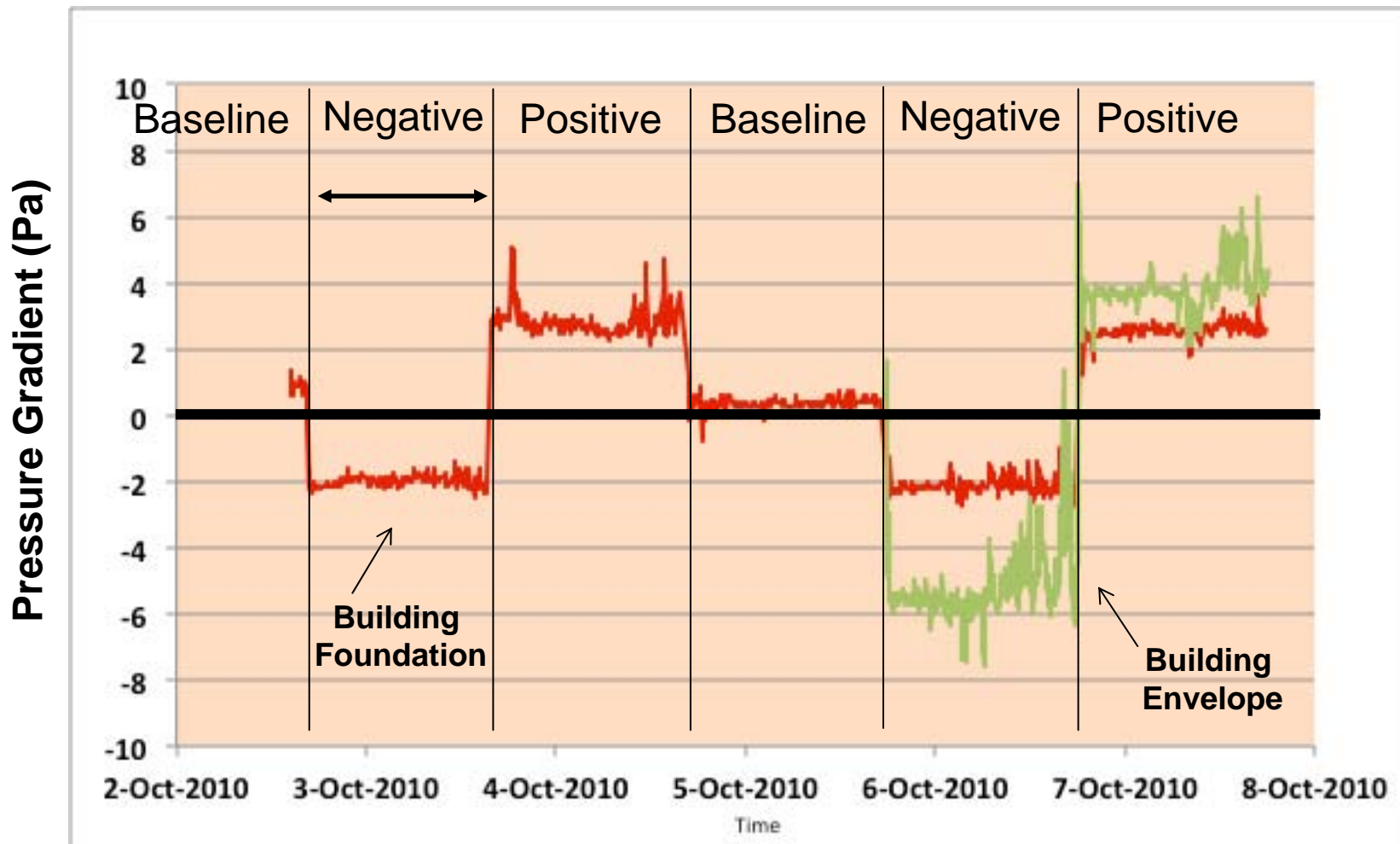


# CONTROL OF BUILDING PRESSURE





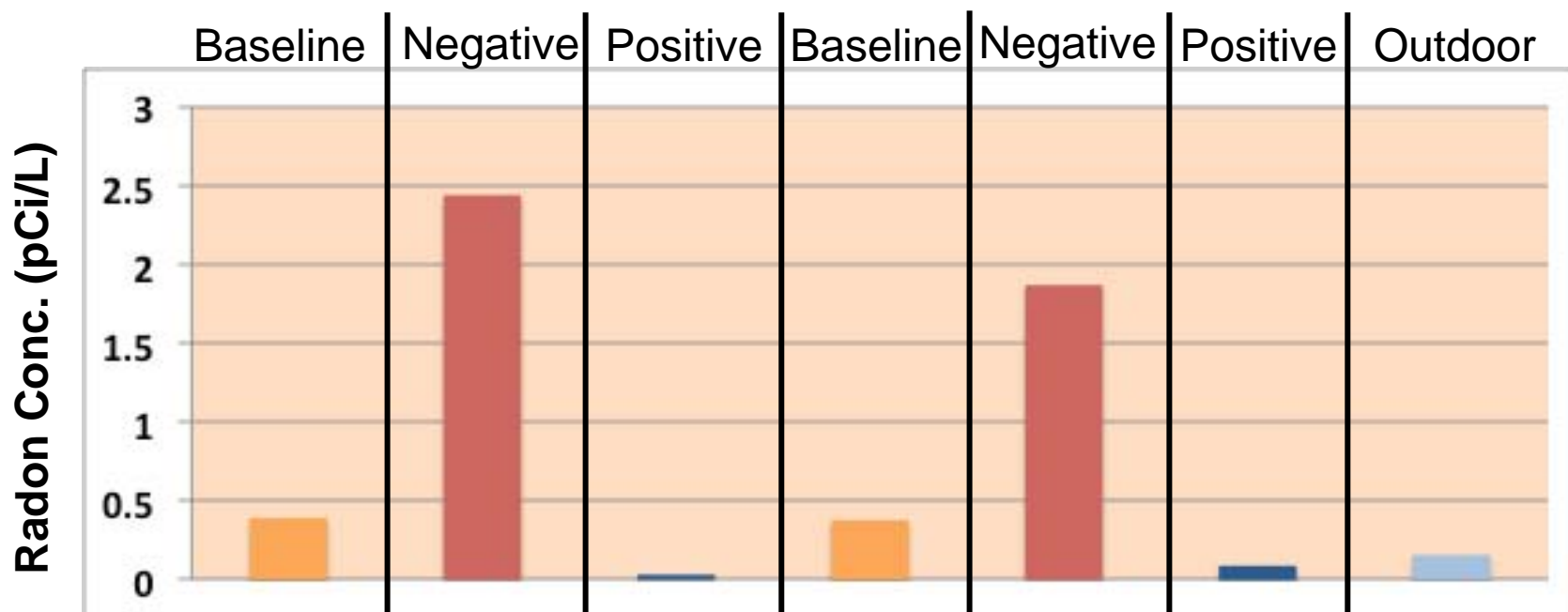
# ASU HOUSE: BUILDING PRESSURE





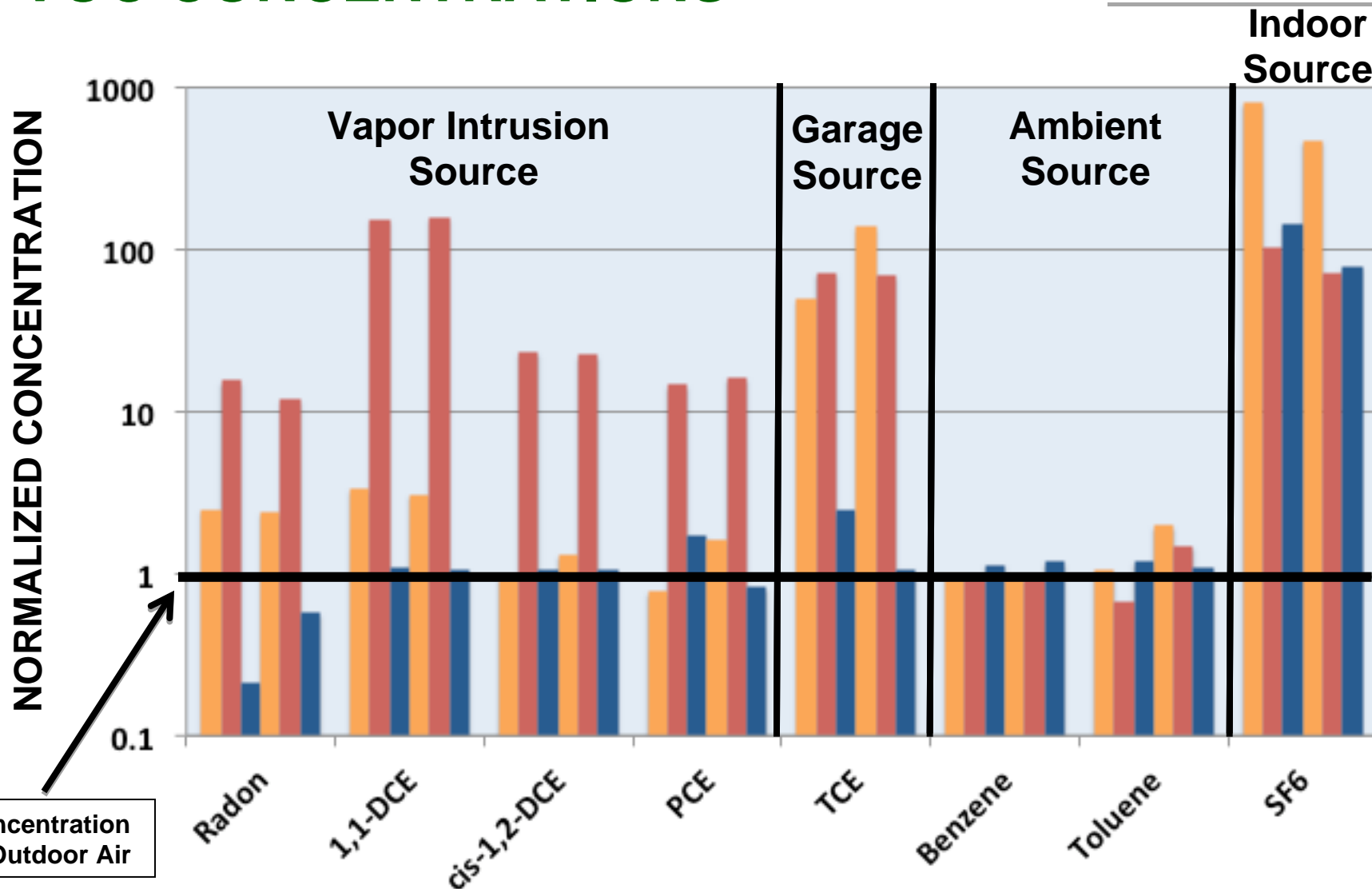
# EFFECT OF BUILDING PRESSURE ON INDOOR RADON CONCENTRATION

## ASU RESEARCH HOUSE



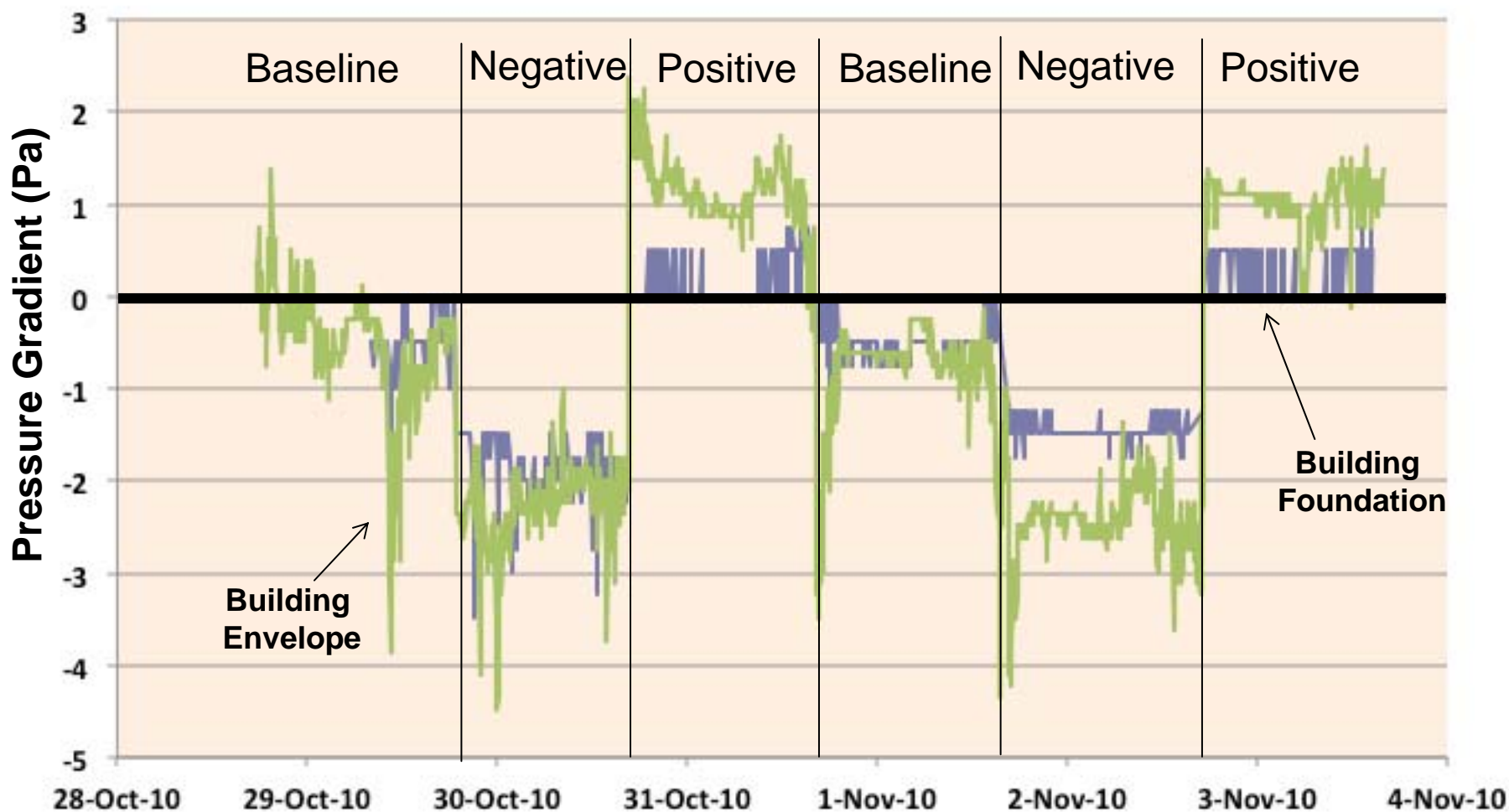
**Key Point:** Control of building pressure resulted in control of radon vapor intrusion.

# ASU HOUSE: VOC CONCENTRATIONS





# MOFFETT BLD 107: BUILDING PRESSURE





# SOLUTION: TEST METHODS

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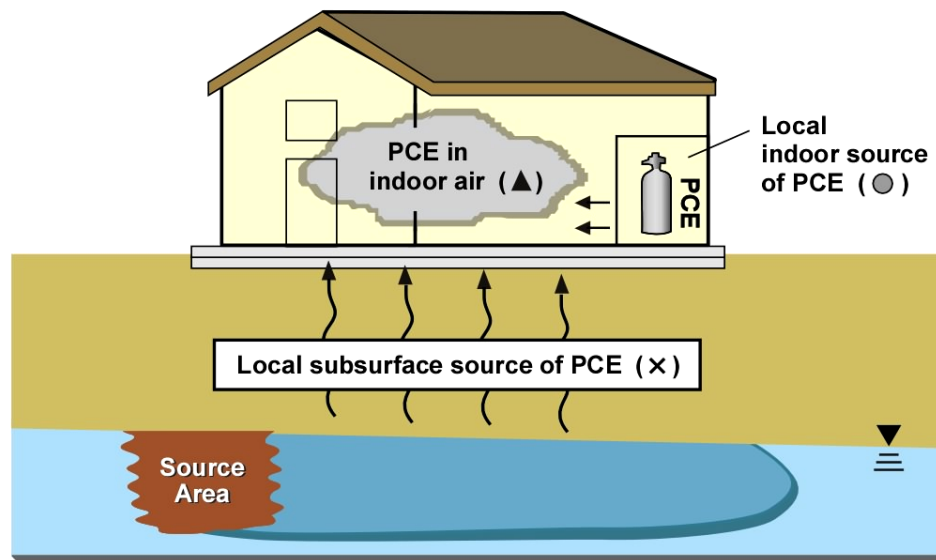
### CSIA / Fingerprinting

- Completed “Proof of Concept” study
- Additional funding for development and validation.

### **KEY POINT:**

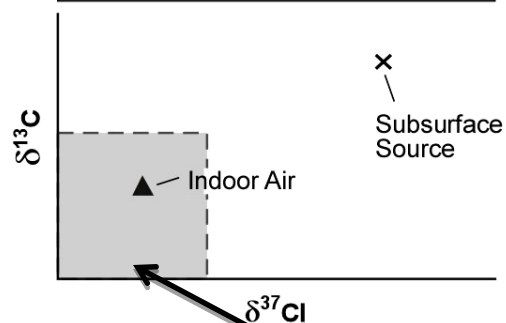
***Multiple methods available to distinguish between vapor intrusion and indoor sources.***

# TECHNOLOGY DESCRIPTION



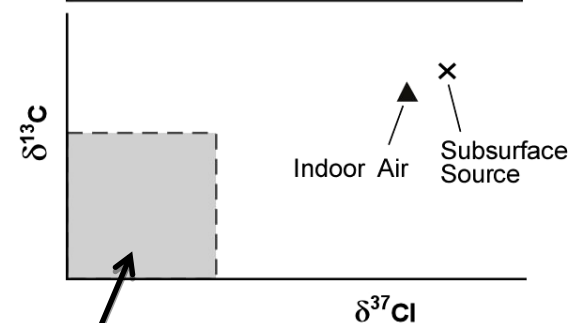
Example A:

**Indoor Source is Primary Source of PCE in Indoor Air**



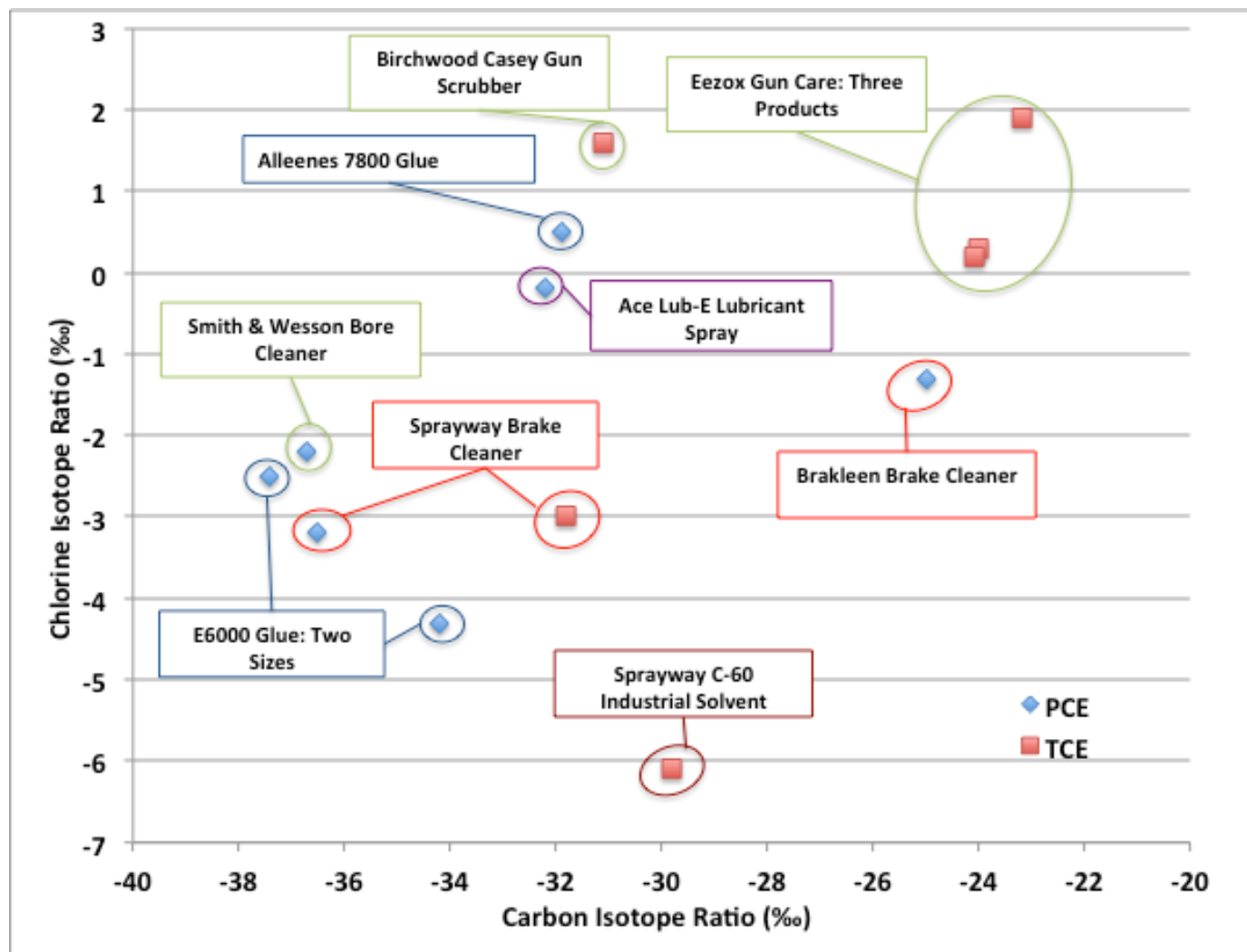
Example B:

**Subsurface Source is Primary Source of PCE in Indoor Air**

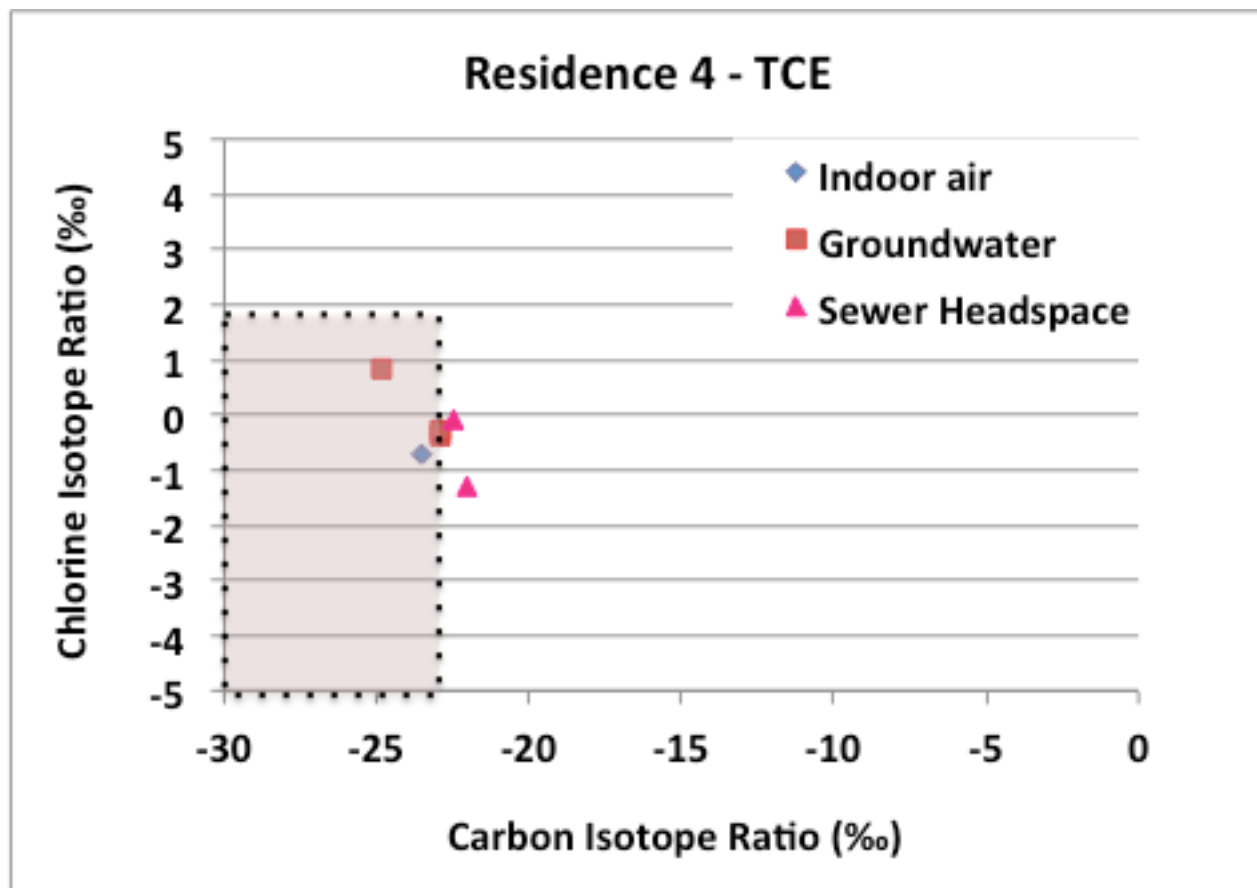


Range for indoor sources

# ISOTOPE RATIOS FOR INDOOR SOURCES



# RESULTS FOR INDOOR AIR



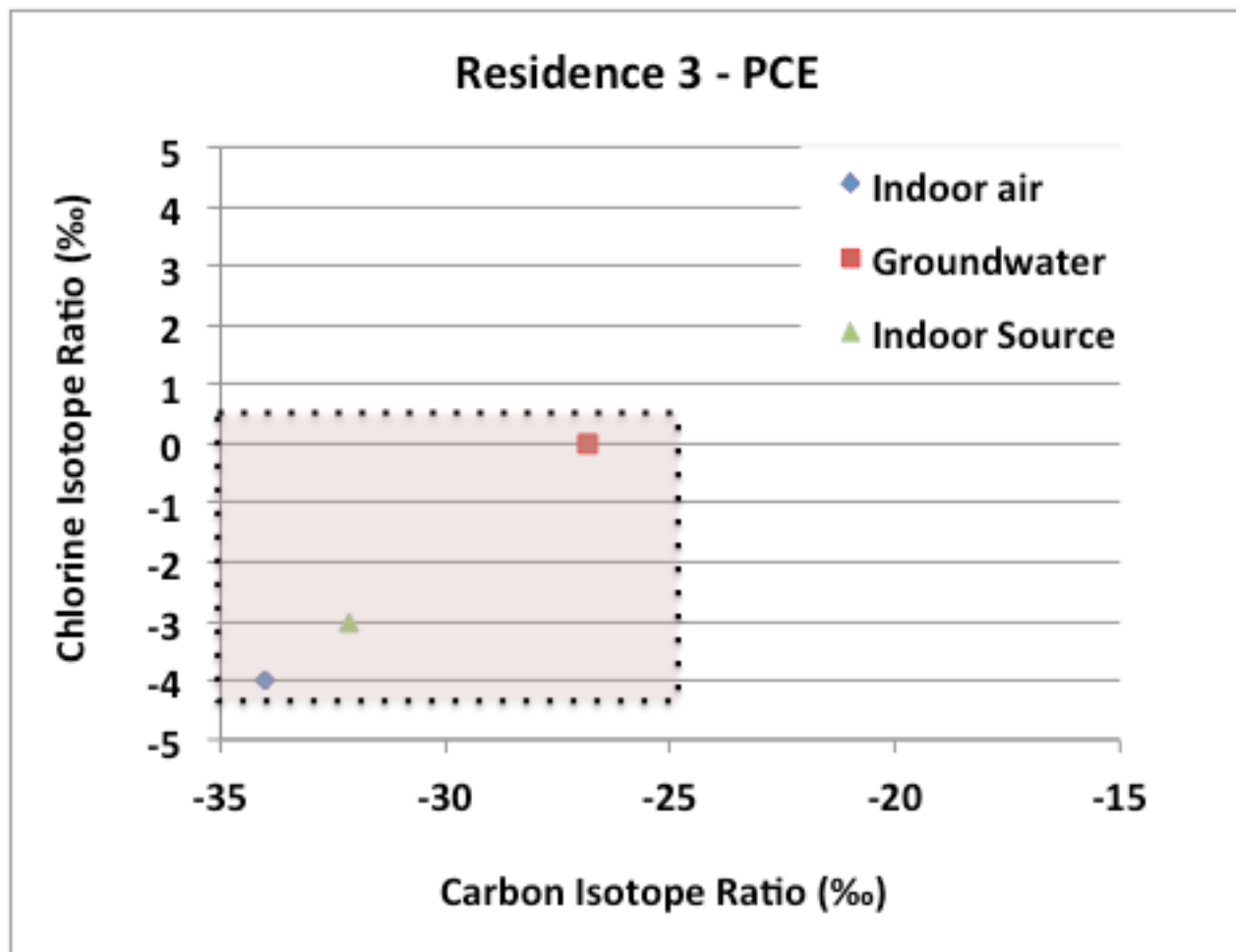
## **FINDING:**

***GW with  
TCE  
discharged  
into sewer.***

***TCE is  
moving  
from sewer  
into house.***



# RESULTS FOR INDOOR AIR



## **FINDING:**

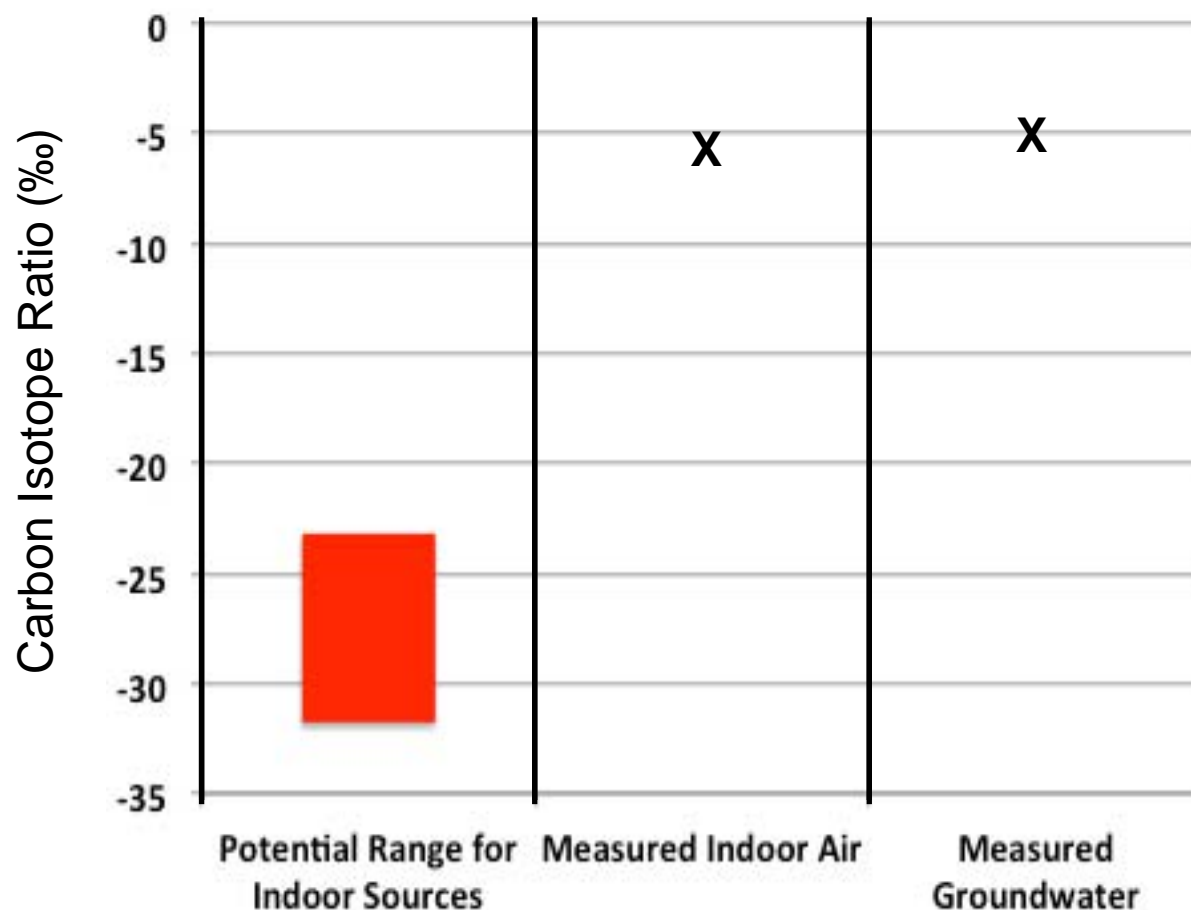
***PCE in indoor air is from indoor source.***

***(Source later identified as E6000 glue)***



# RESULTS FOR INDOOR AIR

Residence 1 - TCE



## **FINDING:**

***TCE in indoor air matches TCE in GW.***

***TCE is too heavy to be an indoor source.***

***> Vapor Intrusion***

# SUMMARY: CSIA FOR VAPOR INTUSION



## Sample Collection

- Sorbent tubes (active sampling) can be used to collect VOC samples for CSIA
  - Conducting further validation to evaluate robustness of sampling method
- 

## Source Identification

- Preliminary results support the hypothesis that INDOOR and SUBSURFACE sources of VOCs will often have different isotope signatures
- 

## CSIA for Vapor Intrusion

- For some buildings, CSIA will provide clear results based on ONE indoor air sample and ONE subsurface sample



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**AFCEE BAA Contract 09-C-8016**

**Hill AFB/BP America – CSIA “Proof of Concept”**

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**Sam Brock & Erica Becvar, AFCEE**

**Erik Dettenmaier, Hill AFB**

**Lisa Molofsky, Danny Bailey, Roberto Landazuri, GSI Env. Inc.**

**Paul Johnson’s Research Team, Arizona State University**

**Beacon Environmental**